Resource Action: EWG-87	**Task Force Recommendation Category: 2**

Modify and/or Operate the Oroville Facilities to Provide Additional Warm Water for Agriculture and Recreational Activities, and Additional Cold Water to Satisfy Salmonid Habitat Requirements.

Description of Potential Resource Action Measure:

This measure would seek to alter the distribution of water temperatures in the Thermalito Afterbay to benefit both salmonids in the lower Feather River downstream of the Thermalito Afterbay outlet and rice farmers that obtain their irrigation water from the Afterbay. The salmonids would benefit from releases of colder water from the Afterbay, while the farmers would benefit from warmer irrigation water, particularly during spring, when the rice germinates. Currently, relatively cold water from the Thermalito Pumping-Generating Plant tail channel discharges into the small northeastern arm of the Thermalito Afterbay (Figure 1). The point of discharge is in the same part of the Afterbay as the outlets to the Western and Richvale Canals, while it is located at the opposite end of the Afterbay from the outlet to the Feather River. During warm weather, water heats up as it moves across the Afterbay and, therefore, the water released to the river is several degrees warmer than that entering the canals, and also warmer than the water already in the river (the Low Flow Channel).

This Resource Measure proposes a variety of structural changes and additions and/or operational changes to effect changes in the distribution of water temperatures in the Afterbay. The structural changes and additions are designed to reduce warming of the water destined to be released to the Feather River at the Afterbay river outlet, while at the same time increasing warming of the water destined to enter the Western and Richvale Canals and other irrigation canals. The structural features would cause the cold water entering the Afterbay to more quickly reach the river outlet and would cause the water used for irrigation to reside longer in the Afterbay before entering the irrigation canals. The result of these changes would be colder water for salmonids in the river and warmer water for the rice farmers. Table 1 provides a list of specific potential actions, including both structural and operational modifications, for improving water temperature distributions in the Afterbay. This list was developed during discussions of the Engineering and Operations Workgroup. The table also notes potential environmental and power effects of each action. The actions are categorized into the following five basic groups, according to their means of effecting temperatures changes:

- Methods to convey cold water to the Afterbay outlet.
- Methods to convey warmer water to the Afterbay agricultural diversion points.
- Methods to increase the residence time of water in the Afterbay.
- Methods to warm the water that has already entered the diversion canals or has already been diverted to individual farms.
- Methods to change the input temperature of water entering the Afterbay.

Table 1. Options for Thermalito Afterbay Temperature Improvements

	Changes to the Oroville Facilities		Effects	
	Operational	Structural	Environmental	Power
A. Convey Cold Water to Thermalito Afterbay Outlet				
Increase flow in LFC from May 1 through June 30	X			X /e/
Construct canal outside of TAB to FR	X	X	X /a/	X /e/
Install a suite of buried pipes in TAB		X	X /b/	
Use baffles to re-direct return flow from canal	X	X	X /b/	
Dredge underwater conveyance channel from Thalweg of TAB (requires facilities to “lift” into outlet)	X	X	X /b/	
Install temperature curtain (to cool water) on the west side of Thermalito Afterbay		X		
Construct canal outside of Thermalito Afterbay to transport water into the Afterbay at another location (presumably southeastern)		X		
B. Convey Warm Water to Agricultural Diversion Canals				
Use baffles to re-direct return flow from conveyance structures	X	X	X /b/	
Draw warmer water for agricultural diversions	X		X /b/	
Install baffles to warm water in Thermalito Afterbay		X		
Install sheet piles to warm water on west side of Thermalito Afterbay		X		
Relocate Sutter Butte Canal Outlet		X		
Relocate Richvale Canal Outlet and Western Canal Outlet		X		
C. Increase Water Residence Time in Thermalito Afterbay				
Smooth agricultural peak demand to allow longer residence time	X			
Manage TAB for agricultural flows (maximize residence time, TAB levels, need baffles)	X	X	X	X /e/
Re-configure island in TAB to redirect water flow and increase residence time	X	X	X	
Connect land islands to partition Thermalito Afterbay		X		
D. Increase Water Temperature After Delivery to Agricultural Diversion Canals				
Install power generation units (no head) at agricultural canal outlets to increase temperature	X	X	X	X /c/
Solar panels on canals with strip heaters in water	X	X	X	X /c/
Stand pipe hot air bubbles at agricultural canal outlets	X	X	X	X /c/
Pump warm air into water to increase water temperature	X	X	X	X /c/
Construct and operate a co-generation plant on Western Canal that uses rice straw waste to increase water temperature	X	X	X	X /c/
Warm Western Canal water by building warming ponds in canals		X /g/		
Place pool solar blankets on TAB	X	X	X	
Develop “shallow” pond to warm water				
Develop warming checks at turnouts – land retirement and purchase for ponding				
E. Change Thermalito Afterbay Inflow Temperature				
Operate Thermalito Afterbay to warmer temperatures from May 1 through June 30	X	X	X	X
Install chillers to cool FRFH water from May 1 through Jun 30	X	X		X /f/
Alternative source of cold water for FRFH (well water or withdraw water from deeper Lake elevations), i.e., Palermo Canal	X	X	X	

/a/ Some impacts to vernal pools would be expected. Such footprint effects could be minimized and mitigated.
/b/ Would result in habitat effects during construction only.
/c/ Effects peaking operations only.
/d/ Effects pump-back operations.
/e/ Effects peaking and pump-back operations.
/f/ Would require electric service
/g/ Ponds would be located outside

The structural changes discussed by the E&O Workgroup to provide colder water at the Afterbay river outlet all involved measures to hasten the movement of the cold Afterbay inflow to the river outlet and to retard the movement of water from the inflow to the irrigation canal outlets. One action would construct a canal to transport cold water directly from the Thermalito Pumping-Generating Plant tail channel to the southeastern portion of the Afterbay, near the river outlet. A related action would install a series of dams or flow barriers to isolate the three principal embayments of the eastern Afterbay from the main body of the Afterbay and would connect these embayments with canals (Figure 1). Both of these actions would speed movement of the cold inflow water to the river outlet and would retard movement of the water destined for the Western, Richvale and Lateral Canals, leading to greater warming. Note, however, that without mitigating actions, the Sutter Canal, which is located close to the river outlet (Figure 1), would likely have colder water than it currently has.

Structural changes to warm the water in the Afterbay include constructing a curtain of sheet pile to isolate the irrigation canal outlets from the main body of the Afterbay (Figure 1). This curtain would increase the distance required for water to travel from the point of inflow to the canals, thus increasing its residence time and amount of warming. This action would be particularly effective if combined with the installation of barriers to contain the cold water inflows in the eastern portion of the Afterbay, as discussed in the previous paragraph and shown in Figure 1. Other structural changes to warm the water for rice farmers include installing various types of heating devices in the irrigation canals.

Several operational changes to warm the Afterbay water were discussed by the E&O Workgroup. One action involved reducing the amplitude of the peak irrigation withdrawals in the spring rice germination period by scheduling each canal to divert at a different time. When the diversions at all canals peak simultaneously, the storage volume of the Afterbay is rapidly exhausted and the water subsequently entering the Afterbay moves quickly from the inflow to the irrigations canals with minimal warming. By moderating the irrigation withdrawals, residence time in the Afterbay is increased and the water entering the irrigation canals would likely remain relatively warm throughout the rice germination period. Another change in operations that was earlier believed to warm Afterbay water temperatures is to increase pump-back operations. However, results of recent water temperature modeling provide little evidence that pump-back operations result in warming of water in the reservoir or in the Thermalito Complex (C. Creel, personal communication).

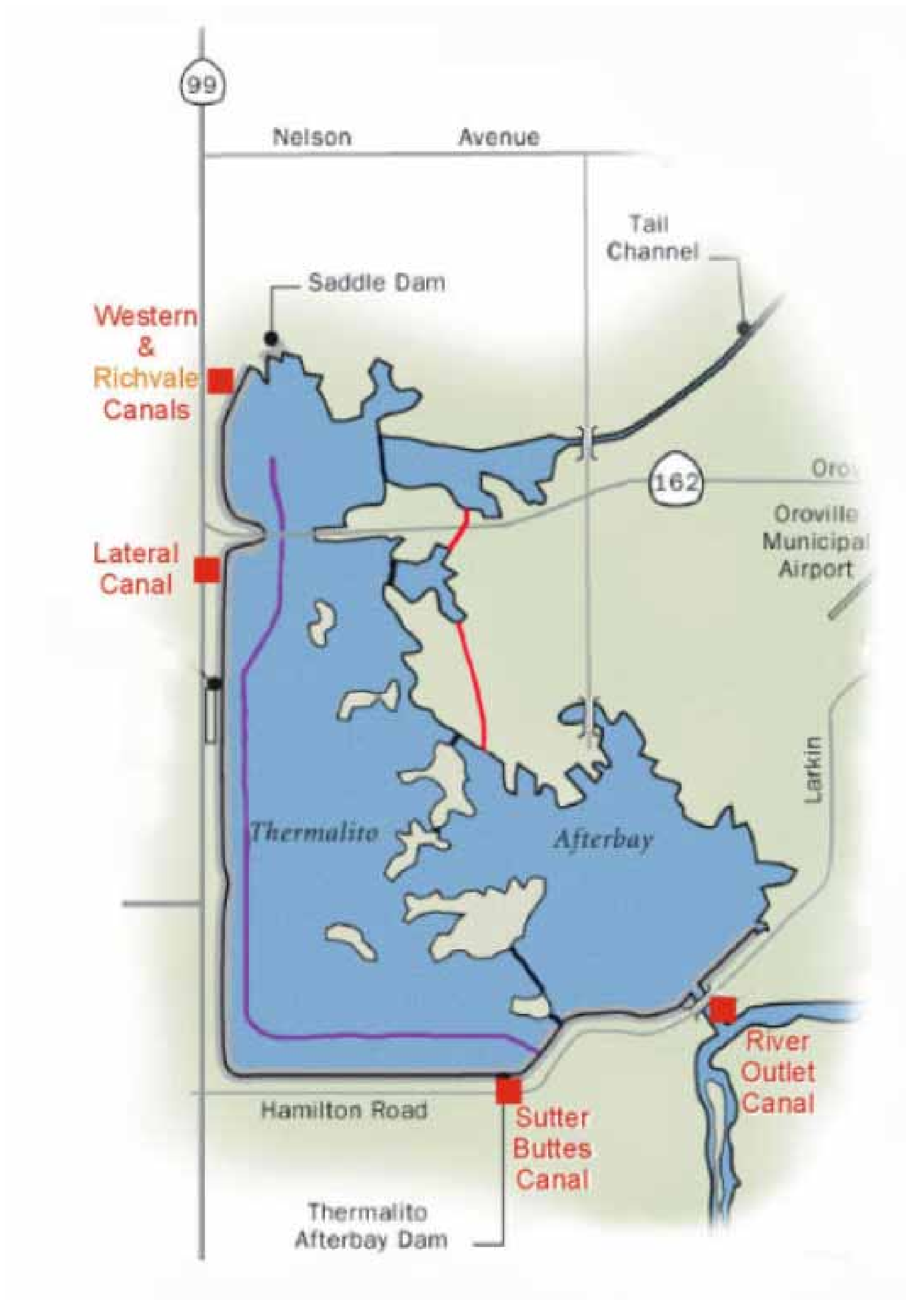

Figure 1. Example of the Thermalito Afterbay with Two Open Channel Conveyance Facilities, Temperature Curtain, and Dams

Date of Field Evaluation: No field evaluation was conducted

Evaluation Team: Phil Unger and Anita Thompson

Related Resource Actions:

- EWG-28, that proposes to manage water levels in the Thermalito Afterbay to provide increased nesting and initial rearing habitat for nesting warmwater species.
- EWG-34A & 34B, which propose to reduce rates of fish predation on juvenile salmonids by reducing water temperatures.
- EWG-35A and EWG-35B, that propose to reduce water temperatures at the Thermalito Afterbay Outlet and in specific areas of the Feather River to reduce the feeding rates of predators on rearing and emigrating juvenile salmonids in the Feather River.
- EWG-36, which proposes to operate the Oroville Facilities in a manner that would provide colder water in the low flow channel of the Feather River for benefit of Chinook salmon and steelhead.
- EWG-37, which proposes to operate the Oroville Facilities in a manner that would provide colder water in Feather River downstream of the Thermalito Afterbay river outlet for benefit of Chinook salmon and steelhead.

- EWG-102, which proposes to provide water temperatures in the lower Feather River that mimic historic (pre Oroville Dam) conditions to help maintain the genetic integrity of the spring-run Chinook salmon.

Nexus to the Project:

Water temperatures in much of the lower Feather River are strongly affected by operations of the Oroville Facilities. The Oroville Facilities allow project operators to regulate the depth in Oroville Reservoir from which water is released, the amount of water released from the reservoir into the river, the amount of water diverted from the LFC of the river through the Thermalito Complex, and the amount of water pumped back into the reservoir from the Thermalito Complex. These operational controls give the operators various degrees of control over water temperatures in the LFC and the upper reaches of the HFC.

The Thermalito Afterbay has important water temperature effects. The Afterbay is large and shallow and, therefore, substantial warming occurs in the Afterbay during warm weather. The warming of water in the Afterbay generally benefits agricultural and recreational users and improves habitat conditions for warm water species in the Afterbay and in the Feather River downstream of the Afterbay outlet. However, the release of warm water from the Afterbay to the river adversely affects coldwater fish species, particularly salmonids. A recent evaluation conducted by the EWG fisheries technical team of Chinook salmon and steelhead water temperature needs in the Feather River suggests that under current Oroville Project operations, the water temperatures in the HFC of the Feather River are seasonally too warm for salmon and steelhead holding, spawning and rearing. Releases of water into the Feather River from the Thermalito Afterbay contribute substantially to the elevated water temperatures of the HFC.

The 1983 agreement between the California Department of Water Resources (DWR) and California Department of Fish and Game (DFG), Concerning the Operation of the Oroville Division of the State Water Project for Management of Fish and Game, established quantitative water temperature criteria for the lower Feather River. In this agreement, the Oroville Project is required to meet quantitative water temperature criteria at two downstream locations: the Feather River Hatchery (FRH) and the LFC at Robinson's Riffle (River Mile 61.6).

The water temperature criteria at the FRH and Robinson's Riffle are the principal water temperature targets controlling Oroville Project operations, but other water temperature objectives and goals occasionally influence project operations and potentially affect water temperatures in the HFC. The 1983 agreement established a narrative water temperature objective for the Feather River downstream of the Thermalito Afterbay river outlet. This objective requires water temperatures downstream of the Thermalito Afterbay outlet that are suitable for fall-run Chinook salmon during the fall (after September 15) and suitable for shad, striped bass and other warmwater species from May through August. This narrative has no direct effect on operations because it is not well defined, but it has encouraged operators to seek opportunities to provide colder water to the HFC during the fall months.

An informal water temperature goal of the Oroville Facilities operators exists for the Thermalito Afterbay. This goal recognizes the need of local rice farmers for warm water temperatures during spring and summer for germination and growth of rice. Most of the rice farmers divert their irrigation water from the Thermalito Afterbay. Water temperature goals to support rice production are a minimum of 65°F during April through mid-May and a minimum of 59°F for the remainder of the growing season. Although DWR is not obligated to meet these goals, Project operators try to accommodate the rice farmers by releasing water as close as possible to the maximum temperature allowed under the FRH criteria. Because most of the water in the Thermalito Afterbay ultimately spills into the HFC of the Feather River, increases in Thermalito Afterbay water temperatures likely produce higher HFC water temperatures.

Potential Environmental Benefits:

This Resource Action would result in release of cooler water from the Thermalito Afterbay outlet to the lower Feather River, which would improve water temperatures for Chinook salmon and steelhead in the HFC. The action would provide the greatest benefit to salmon and steelhead during April through October. This period includes the rearing period for spring-run Chinook salmon and steelhead and the immigration, holding and spawning period for spring-run Chinook salmon.

The EWG fisheries team determined Chinook salmon and steelhead water temperature needs for each life-stage by synthesizing information obtained from the fisheries literature. Both fall-run and spring-run Chinook salmon spawn in the LFC beginning in early September. The upper reaches of the HFC have an abundance of suitable spawning gravels, but limited spawning occurs in the HFC because water temperatures are generally too warm.

The EWG team determined that spawning and egg incubation water temperature requirements for Chinook salmon are no more than 56°F or 58°F (the two values reflect minor differences in the set of literature sources used for deriving the critical temperature estimates). Based on benchmark study water temperature modeling runs of existing (2001) conditions, the September median daily average water temperatures in the HFC ranged from about 62 °F downstream of the Afterbay outlet to about 67°F upstream of Honcut Creek, and the 95th percentile of daily maximum water temperatures ranged from about 67°F to 74°F (Figure 2). These results indicate that a substantial reduction in water temperatures in September would be required to provide suitable spawning conditions for the Chinook salmon in the HFC. The analysis of water temperatures is limited to the HFC upstream of Honcut Creek because this portion of the HFC has the best spawning habitat conditions and because, realistically, modifications to the Oroville Facilities or their operations would be unable to affect water temperature further downstream.

Steelhead begin spawning about December, but continue spawning until about April, and egg incubation may continue through May. The EWG fisheries technical team determined that spawning and egg incubation temperature requirements for steelhead are 52°F and 54°F (again, the two values reflect differences in the set of literature sources used for estimates). Based on the existing conditions benchmark study modeling results, the median daily average and the 95th percentile of daily maximum water temperatures in the HFC were consistently higher than the steelhead spawning and egg incubation temperature requirements (Figure 2). Substantial reductions in water temperatures would be required to provide suitable conditions for steelhead egg incubation.

Providing cooler water temperatures in the HFC during the summer months could benefit spring-run and fall-run Chinook salmon. Spring-run adults hold in pools in the lower Feather River from late spring through summer. Fall-run migrate upstream in late summer and hold more briefly. The EWG fisheries technical team determined that upstream migration and holding temperature requirements for adult spring-run and fall-run Chinook salmon are 60°F and 64°F (the two values reflect differences in the set of literature sources used for estimates). During the summer months (June through September), the median daily average and 95th percentile of maximum water temperatures at both locations in the HFC were generally higher than these temperature requirements (Figures 2). Therefore, reducing water temperatures from June through September would likely benefit migrating and holding Chinook salmon, particularly spring-run Chinook salmon, by providing additional holding habitat in the upstream section of the HFC.

In addition to improving holding, spawning and rearing conditions for salmon and steelhead, releasing colder water from the Thermalito Afterbay may also enhance juvenile salmonid survival by reducing predation from warmwater fish species. Providing warmer water to the irrigation canals in the Afterbay provides clear benefits to farmers, particularly rice farmers. As discussed previously, the spring period of rice germination is the most important for warm water deliveries. Warm water in the Afterbay would also benefit the existing warmwater fisheries as well as swimming and other contact recreational activities. However, this Resource Action would likely not increase water temperatures throughout the Afterbay, so the benefit to warmwater fish species and recreation would depend on the distribution of the fish and locations of recreational facilities.

Potential Constraints:
This Resource Action could be constrained by regulatory requirements. The narrative objective for water temperatures in the HFC below the Thermalito Afterbay river outlet requires water temperatures that are suitable for shad, striped bass and other warmwater species from May through August. Releasing colder water from the Afterbay to the HFC during the spring and summer could make it difficult to meet this objective.

Measures to reduce water temperatures of the releases from the Afterbay are also potentially constrained by the goal to provide suitable warm water for recreational activities in the HFC and needs of irrigators that divert water from the HFC.

A major constraint of some of the measures proposed for this Resource Action is a loss of generation resulting from the elimination of pump-back operations. For example, the second item listed in Table 1 would bypass the Afterbay entirely, thus eliminating the capability of pump-back operations.

Structural changes in the Afterbay may have recreational as well as environmental effects that would have to be considered. For instance, installation of barriers and curtains would greatly constrain boating opportunities in the Afterbay. The reduction of water temperatures along the eastern margin of the Afterbay would reduce enjoyment of existing swimming areas. In addition, construction associated with some of the proposed structural changes would potentially affect vernal pools east of the Afterbay. Other potential environmental and power generation effects of this Resource Action are listed in Table 1.

Existing Conditions in the Proposed Resource Action Implementation Area:
The Thermalito Afterbay is situated downstream of the Thermalito Forebay, which is located downstream of the Thermalito Diversion Pool and Oroville Reservoir. Water from the Afterbay is released through the Thermalito Afterbay outlet into the Feather River downstream of the Low Flow Channel. Some Afterbay water is also diverted into irrigation canals. The Afterbay provides storage for the pump-back operation to Lake Oroville. The facility also provides recreational opportunities and provides agricultural water for several local irrigation districts. The water surface area of the facility at maximum operating storage is 4,300 acres.

The Thermalito Afterbay has a diverse water temperature regime. During the warmer times of year, the temperature of water released from the Afterbay to the Feather River is warmer than that already in the river because the water diverted through the Thermalito Complex has a longer residence time, including time in shallow reservoirs, than the water in the LFC. The Afterbay is much the largest reservoir in the Thermalito Complex and accounts for most of the warming. The combination of cold inflowing water and large areas of shallow water results in a wide range of water temperatures within the Thermalito Afterbay. This wide range of temperatures, the adverse effects of warm water releases on the coldwater fisheries of the river, and the benefits of providing warm water to the irrigation canals result in a complicated water temperature management program for the Afterbay.

The upstream section of the HFC, extending about 14 miles from the Thermalito Afterbay Outlet to Honcut Creek, is the portion of the Feather River most affected by this Resource Action. The minimum flows and the water temperature targets in the HFC are established by a 1983 agreement between DWR and DFG. The instream flow requirements are 1,700 cfs from October through March and 1,000 cfs from April through September for wetter years (> 55% of normal runoff), and 1,200 cfs for October through February and 1,000 cfs for March through September for drier years. As previously described, the water temperature must be suitable for fall-run Chinook salmon after September 15, and they must be suitable for shad, striped bass, and other warmwater species, from May through August.

Spring and summer water temperatures in the HFC are typically quite a bit warmer than those in the LFC in large part because of the large volumes of relatively warm water released to the HFC from the Thermalito Afterbay outlet. As previously described, water temperatures in the Afterbay are relatively high because of the Afterbay is large and shallow and has a long residence time. The contribution of the Afterbay outlet releases to the total flow of the HFC is typically greater than that of the LFC flow.

The release of large flows with relatively high water temperatures from the Thermalito Afterbay outlet typically results in a sharp thermal gradient from the downstream end of the LFC to the upstream end of the HFC. Based on results of water temperature monitoring conducted in 2002 and 2003, water temperatures in the HFC just downstream of the Afterbay outlet are often several degrees warmer (as much as 8^{o}F in early June 2002) than temperatures in the lower part of the LFC (upstream of Thermalito Afterbay Outlet), particularly in the late spring and early summer (Figure 3). This change in water temperature may be stressful for migrating fishes, but also elevates predation risk because of the increased abundance of piscivorous bass and Sacramento pikeminnow.

Design Considerations and Evaluation:
DWR's Division of Engineering (DOE) is performing an initial estimate of cost for several design options that include open channel conveyance facilities and systems of small dams and dikes to convey the cold Afterbay inflow water more directly to the Feather River. The cost information along with the water temperature data that have been collected in the field are the basis for a reconnaissance-level evaluation of the potential changes in water temperatures. Other reconnaissance-level analyses regarding environmental and recreational impacts may be necessary before staff would be able to provide a recommendation to DWR management.

DOE's analyses of construction costs suggest that conveyance facilities range between $14 million and $22 million. Below are brief descriptions of the options that were analyzed.

- Segregate cold water from the rest of the Afterbay. This design option proposes construction of a temperature curtain along the eastern edge of Thermalito Afterbay. The initial cost estimate is approximately $15 million.

- Construct canals to convey some of the water. Two of DOE's design options propose construction of open conveyance channels to re-direct water from the northernmost portion of the Afterbay to a region closer to Afterbay river outlet. One of these design options includes a lined channel and the other includes an unlined channel. The channels would be large enough to convey all of the water that is destined for release to the river about 80% of the time. However, some water would overflow into the northern portion of the Afterbay during peaked operations. Initial cost estimates for these two design options are approximately $14 million and $11 million, respectively.

- Construct canals to convey all of the water. These options are the same as the set above except the canals would be capable of conveying the full capacity of the power plant. The initial cost estimate for these options are $22 million and $18 million, respectively.

Based upon the assumption that it would be desirable to convey cold water more efficiently to the Thermalito Afterbay river outlet, any of the above options could merit further study and analyses. However, an expected drawback of all these options, is that they would likely reduce the temperature of water diverted at Sutter Buttes Canal. Therefore, these options would likely need to be paired with options to convey warmer water to the agricultural diversion points. Figure 1 shows an example how two options could be combined to both reduce the temperature of water released to the river while avoiding significant reductions in water temperatures to agricultural diversions.

The effectiveness of this Resource Action would be evaluated by comparing water temperatures measured at the Thermalito Afterbay outlet, all the Afterbay irrigation canal outlets and several locations in the HFC before and after implementing the action. The comparisons would use water temperature modeling to adjust for differences in atmospheric conditions and other potentially confounding variables in making the comparisons. Water temperature data currently being collected in the Afterbay, the irrigation canals, and the lower Feather River will provide the information on water temperatures before implementing any changes in project operations.

Synergisms and Conflicts:
This Resource Action is compatible with the resource goals described in EWG-36 and EWG-37, which provide additional cold water for Chinook salmon and steelhead. By benefiting coldwater fishes, the Resource Action would likely enhance recreation in the HFC, providing increased summer angling opportunities for trout and Chinook salmon. This Resource Action would likely reduce the steep thermal gradient between the HFC and the LFC and thereby improve upstream passage and habitat conditions for anadromous salmonids, which are resource goals of many of the proposed resource actions. The colder water that would result from this measure might also help reduce predation on juvenile salmonids because the colder water would reduce metabolic rates of the fish predators in the HFC, and thereby potentially reduce their feeding rates. Reduced predation on juvenile salmonids is the resource goal for Resource Actions EWG-35A, EWG-35B and EWG- 27.

Currently the Thermalito Afterbay provides storage for the water required by the pump-back operation to Lake Oroville. As noted earlier, one of the measures proposed for this Resource Action bypass the Afterbay, which would eliminate the possibility of pump-back operations. Other measures would likely also interfere to some degree with pump-back operations.

As previously described, the Resource Action would potentially conflict with fisheries and recreational opportunities in the Afterbay and could have impacts on vernal pools east of the Afterbay. Public safety issues must also be considered and analyzed regarding the installations of structures in the Afterbay.

Uncertainties:
An important uncertainty regarding this Resource Action concerns its effectiveness in controlling spring water temperatures. Based on water temperature data collected in 2002 and 2003 and analyses of the E&O Workgroup, it appears that water temperatures in the Afterbay closely track air temperatures during early spring. As spring air temperatures increase, the residence time of the water in Afterbay becomes increasingly important in determining Afterbay water temperatures. If, as these results

seem to indicate, residence time has little effect on Afterbay water temperatures during spring, then the many measures included in this Resource Action to increase residence time may not have the desired effect of warming water for rice farmers during the spring, and other measures, such as releasing warmer water from Oroville Reservoir, would be required to meet rice farmers' water temperature goals. More generally speaking, there is no guarantee that installation of the proposed structures in and around the Afterbay would result in satisfying the water temperatures needs of all beneficial uses.

Other uncertainties regarding this Resource Action include the following:

- Effect on the fish rearing facility at Thermalito Annex near the Thermalito Afterbay.
- Whether the Resource Action could be implemented without conflicting with DWR agreements or goals, including the FRH water temperature criteria, the agreement to accommodate water temperature needs of rice farmers, and the agreement to provide water temperatures downstream of the Thermalito Afterbay outlet from May through August that are suitable for shad, striped bass and other warmwater species.
- The amount of revenue that would be lost because of changes in power generation.

Although, as previously noted, results of recent water temperature modeling seem to indicate that Thermalito pumpback operations minimally affect water temperatures; more analysis is needed to resolve this matter.

A major challenge for considering this proposed resource action is cost and financing. DWR must consider means by which the construction costs will be financed and repaid. It is likely that financing and repayment of this proposed resource action will be a subject of settlement negotiations.

Cost Estimate:
DOE is currently reviewing the cost of several options for designing the proposed open channel conveyance facilities and system of small dams and dikes.

Recommendations:
DWR, within the E&O Work Group may wish continue to review the costs and potential benefits of several options for designing the proposed open channel conveyance facilities and system of small dams and dikes.

Figure 2. Median of Daily Average, 95th Percentile of Daily Maximum, and 5th Percentile of Daily Minimum Water Temperatures for Benchmark Study Conditions; High Flow Channel Stations

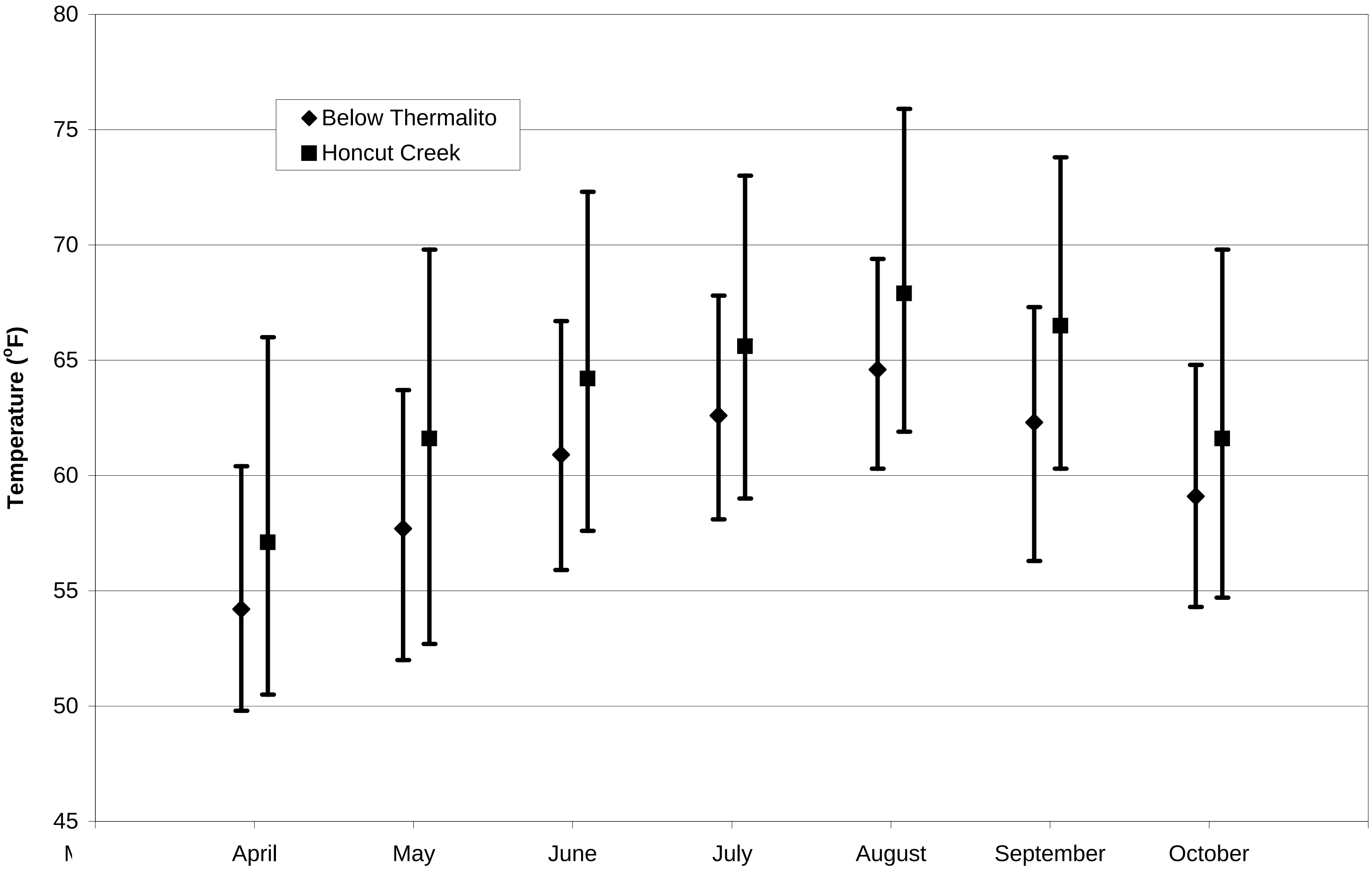

Figure 3. Differences in Daily Average Water Temperatures between Sites Downstream and Upstream of the Afterbay in 2002 and 2003